

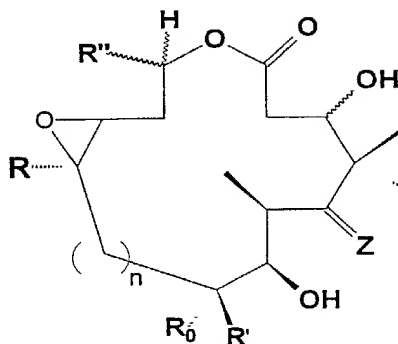


wherein R is H, methyl, ethyl, n-propyl, n-butyl, n-hexyl,  or  or

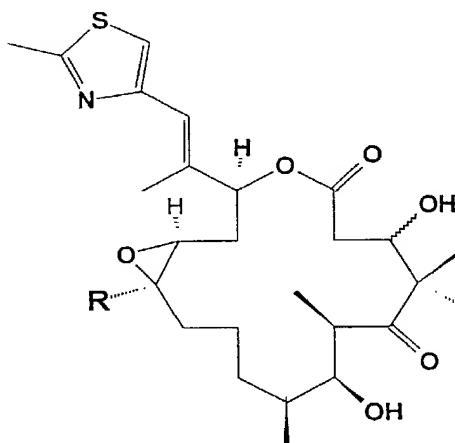
$$(\text{CH}_2)_3\text{-OH}.$$

3. A compound having the structure:



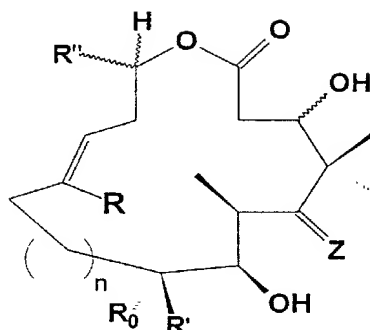
wherein R, R₀, and R' are independently H, linear or branched chain alkyl, optionally substituted by hydroxy, alkoxy, carboxy, carboxaldehyde linear or branched alkyl or cyclic acetal, fluorine, NR₁R₂, N-hydroximino, or N-alkoxyimino, wherein R₁ and R₂ are independently H, phenyl, benzyl, linear or branched chain alkyl; wherein R'' is -CHY=CHX, or H, linear or branched chain alkyl, phenyl, 2-methyl-1,3-thiazolynyl, 2-furanyl, 3-furanyl, 4-furanyl, 2-pyridyl, 3-pyridyl, 4-pyridyl, imidazolyl, 2-methyl-1,3-oxazolynyl, 3-indolyl or 6-indolyl; and wherein X is H, linear or branched chain alkyl, phenyl, 2-methyl-1,3-thiazolynyl, 2-furanyl, 3-furanyl, 4-furanyl, 2-pyridyl, 3-pyridyl, 4-pyridyl, imidazolyl, 2-methyl-1,3-oxazolynyl, 3-indolyl or 6-indolyl; wherein Y is H or linear or branched chain alkyl; wherein Z is O, N(OR₃) or N-NR₄R₅, wherein R₃, R₄ and R₅ are independently H or a linear or branched chain alkyl; and wherein n is 0, 1, 2, or 3.

4. The compound of claim 3 having the structure:



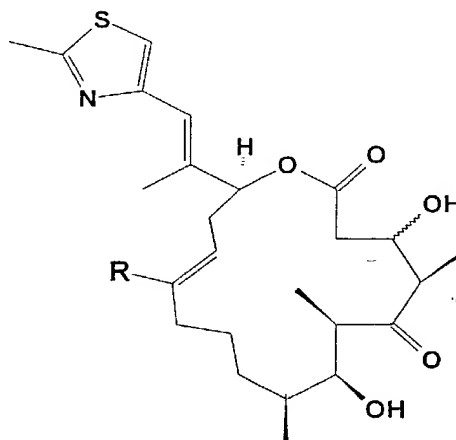
wherein R is H, methyl, ethyl, n-propyl, n-butyl or n-hexyl.

2



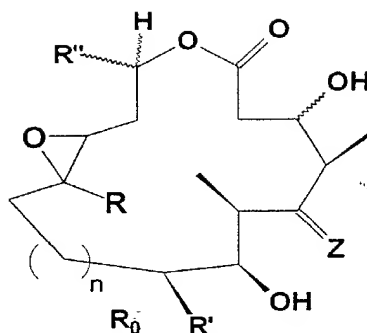
wherein R, R₀, and R' are independently H, linear or branched chain alkyl, optionally substituted by hydroxy, alkoxy, carboxy, carboxaldehyde linear or branched alkyl or cyclic acetal, fluorine, NR₁R₂, N-hydroximino, or N-alkoxyimino, wherein R₁ and R₂ are independently H, phenyl, benzyl, linear or branched chain alkyl; wherein R" is -CHY=CHX, or H, linear or branched chain alkyl, phenyl, 2-methyl-1,3-thiazolynyl, 2-furanyl, 3-furanyl, 4-furanyl, 2-pyridyl, 3-pyridyl, 4-pyridyl, imidazolyl, 2-methyl-1,3-oxazolynyl, 3-indolyl or 6-indolyl; and wherein X is H, linear or branched chain alkyl, phenyl, 2-methyl-1,3-thiazolynyl, 2-furanyl, 3-furanyl, 4-furanyl, 2-pyridyl, 3-pyridyl, 4-pyridyl, imidazolyl, 2-methyl-1,3-oxazolynyl, 3-indolyl or 6-indolyl; wherein Y is H or linear or branched chain alkyl; wherein Z is O, N(OR₃) or N-NR₄R₅, wherein R₃, R₄ and R₅ are independently H or a linear or branched chain alkyl; and wherein n is 0, 1, 2, or 3.

2

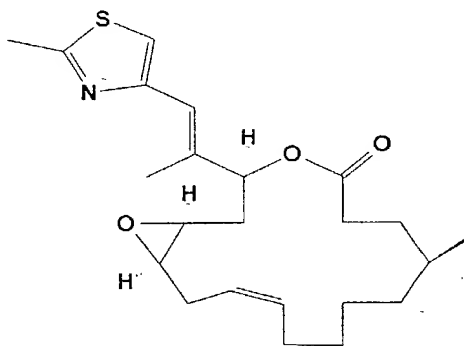


4 wherein R is H, methyl, ethyl, n-propyl, n-butyl, n-hexyl or hydroxypropyl.

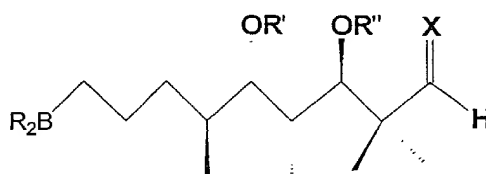
1



8. A compound having the structure:



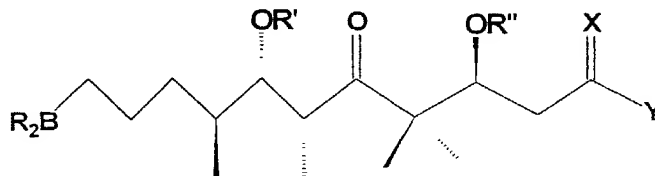
9. A compound having the structure:



wherein R' and R'' are independently hydrogen, a linear or branched alkyl,

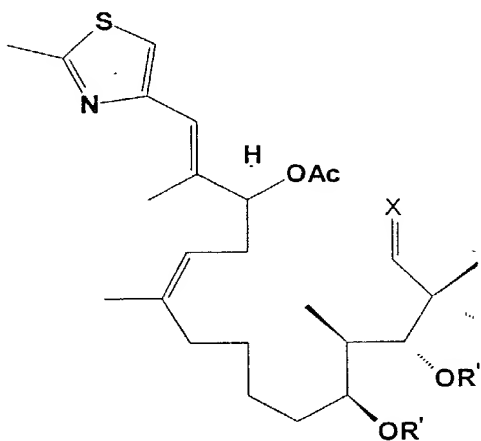
5 substituted or unsubstituted aryl or benzyl, trialkylsilyl, dialkylarylsilyl,
6 alkyldiarylsilyl, a linear or branched acyl, substituted or unsubstituted aroyl or
7 benzoyl; wherein X is oxygen, $(OR^*)_2$, $(SR^*)_2$, $-(O-(CH_2)_n-O)-$, $-(O-(CH_2)_n-S)-$ or $-(S-$
8 $(CH_2)_n-S)-$; wherein R^* is a linear or branched alkyl, substituted or unsubstituted aryl
9 or benzyl; wherein R_2B is a linear, branched or cyclic alkyl or substituted or
10 unsubstituted aryl or benzyl boranyl moiety; and wherein n is 2, 3 or 4.

1 10. A compound having the structure:
2



3 wherein R' and R'' are independently hydrogen, a linear or branched alkyl,
4 substituted or unsubstituted aryl or benzyl, trialkylsilyl, dialkylarylsilyl,
5 alkyldiarylsilyl, a linear or branched acyl, substituted or unsubstituted aroyl or
6 benzoyl; wherein X is oxygen, $(OR^*)_2$, $(SR^*)_2$, $-(O-(CH_2)_n-O)-$, $-(O-(CH_2)_n-S)-$ or $-(S-$
7 $(CH_2)_n-S)-$; wherein R^* is a linear or branched alkyl, substituted or unsubstituted aryl
8 or benzyl; wherein R_2B is a linear, branched or cyclic alkyl or substituted or
9 unsubstituted aryl or benzyl boranyl moiety; wherein Y is OH, linear or branched
10 chain alkoxy, trimethylsilyloxy, t-butyldimethylsilyloxy or methyldiphenylsilyloxy; and
11 wherein n is 2, 3 or 4.
12

1 11. A compound having the structure:
2



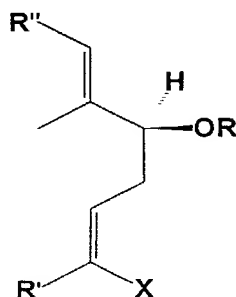
3 wherein R' and R'' are independently hydrogen, a linear or branched alkyl,
4 substituted or unsubstituted aryl or benzyl, trialkylsilyl, dialkylarylsilyl,
5 alkyldiarylsilyl, a linear or branched acyl, substituted or unsubstituted aroyl or
6 benzoyl; wherein X is oxygen, $(OR)_2$, $(SR)_2$, $-(O-(CH_2)_n-O)-$, $-(O-(CH_2)_n-S)-$ or $-(S-$
7 $(CH_2)_n-S)-$

8 (CH₂)_n-S-; and wherein n is 2, 3 or 4.

1 12. The compound of claim 11 wherein R' is TBS, R'' is TPS and X is (OMe)₂.

1 13. A compound having the structure:

2



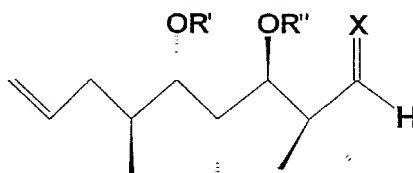
3

4 wherein R is hydrogen, a linear or branched alkyl, alkoxyalkyl, substituted or
5 unsubstituted aryloxyalkyl, linear or branched acyl, substituted or unsubstituted aroyl
6 or benzoyl; wherein X is a halogen; wherein R'' is H, linear or branched chain alkyl,
7 phenyl, 2-methyl-1,3-thiazolyl, 2-furanyl, 3-furanyl, 4-furanyl, 2-pyridyl, 3-pyridyl,
8 4-pyridyl, imidazolyl, 2-methyl-1,3-oxazolyl, 3-indolyl or 6-indolyl; and wherein Y
9 is H or linear or branched chain alkyl.; wherein R' is H, linear or branched chain
10 alkyl, hydroxymethyl, hydroxypropyl, alkyl carboxaldehyde, alkyl carboxaldehyde
11 linear or cyclic acetal; and X is a halide.

1 14. The compound of claim 13 wherein R is acetyl and X is iodo.

1 15. A compound having the structure:

2



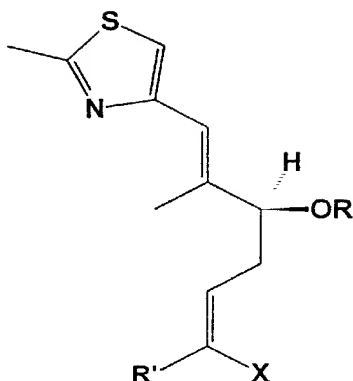
3

4 wherein R' and R'' are independently hydrogen, a linear or branched alkyl,
5 substituted or unsubstituted aryl or benzyl, trialkylsilyl, dialkylarylsilyl,
6 alkylarylsilyl, a linear or branched acyl, substituted or unsubstituted aroyl or
7 benzoyl; wherein X is oxygen, (OR)₂, (SR)₂, -(O-(CH₂)_n-O)-, -(O-(CH₂)_n-S)- or -(S-
8 (CH₂)_n-S-; and wherein n is 2, 3 or 4.

1 16. A compound having the structure:

- 95 -

2



3

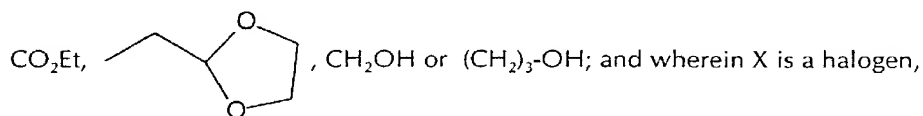
4

5

6

wherein R is hydrogen, a linear or branched alkyl, alkoxyalkyl, substituted or unsubstituted aryloxyalkyl, linear or branched acyl, substituted or unsubstituted aroyl or benzoyl; wherein R' is hydrogen, methyl, ethyl, n-propyl, n-hexyl,

7



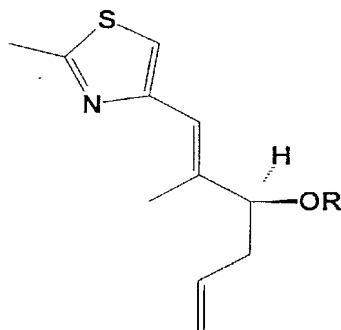
8

9

10

which comprises

(a) oxidatively cleaving a compound having the structure:



11

12

13

14

under suitable conditions to form an aldehyde intermediate; and

(b) condensing the aldehyde intermediate with a halomethylene transfer agent under suitable conditions to form the Z-haloalkene ester.

1

19. The method of claim 18 wherein X is iodine.

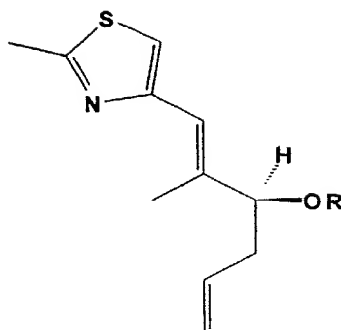
1

20. The method of claim 18 wherein the halomethylene transfer agent is Ph₃P=CR'I or (Ph₃P⁺CHR'I)⁻

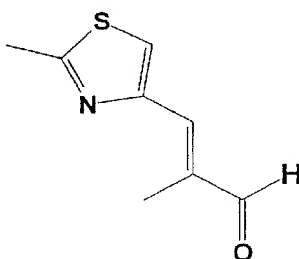
2

1

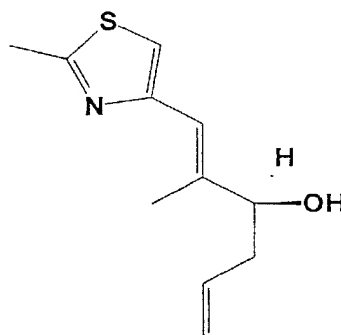
21. A method of preparing an optically pure compound having the structure:



(a) condensing an allylic organometallic reagent with an unsaturated aldehyde having the structure:



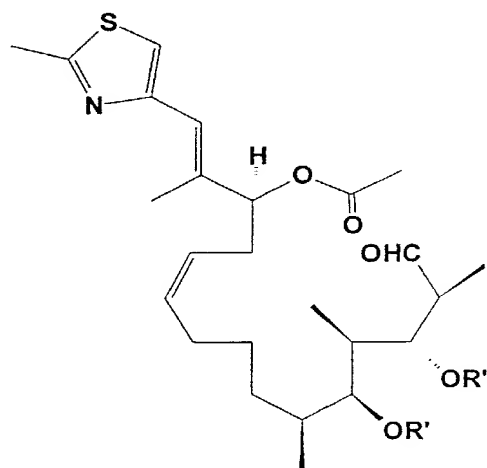
under suitable conditions to form an alcohol, and, optionally concurrently therewith, optically resolving the alcohol to form an optically pure alcohol having the structure:



(b) alkylating or acylating the optically pure alcohol formed in step (a) under suitable conditions to form the optically pure compound.

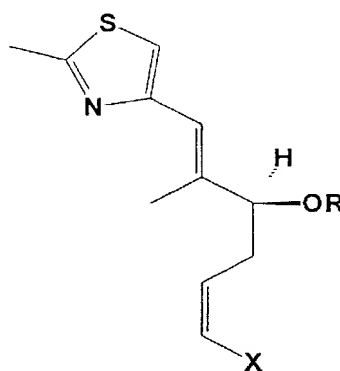
22. The method of claim 21 wherein the allylic organometallic reagent is an allyl(trialkyl)stannane.

- 1 23. The method of claim 21 wherein the condensing step is effected using a reagent
2 comprising a titanium tetraalkoxide and an optically active catalyst.
- 1 24. The method of claim 23 wherein the optically active catalyst is
2 S(-)BINOL.
- 1 25. A method of preparing an open-chain aldehyde having the structure:
2



3 wherein R' and R'' are independently hydrogen, a linear or branched alkyl,
4 substituted or unsubstituted aryl or benzyl, trialkylsilyl, dialkylarylsilyl,
5 alkyldiarylsilyl, a linear or branched acyl, substituted or unsubstituted aroyl or
6 benzoyl, which comprises:

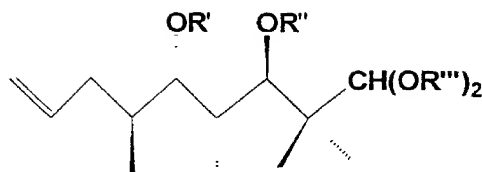
- 7 (a) cross-coupling a haloolefin having the structure:



10 wherein R is a linear or branched alkyl, alkoxyalkyl, substituted or
11 unsubstituted aryloxyalkyl, trialkylsilyl, aryldialkylsilyl, diarylalkylsilyl,
12 triarylsilyl, linear or branched acyl, substituted or unsubstituted aroyl or
13 benzoyl, and X is a halogen, with a terminal olefin having the structure:
14

- 98 -

15



16

17

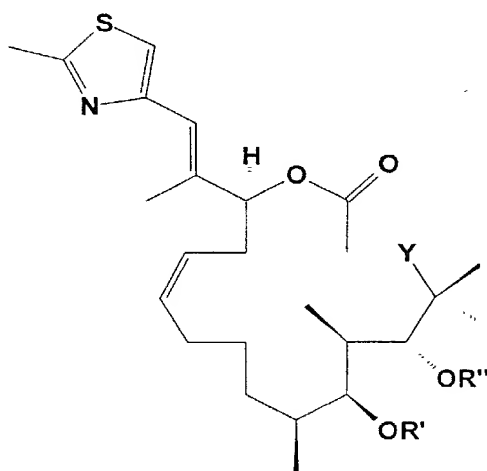
18

19

20

21

wherein $(OR''')_2$ is $(OR_0)_2$, $(SR_0)_2$, $-(O-(CH_2)_n-O)-$, $-(O-(CH_2)_n-S)-$ or $-(S-(CH_2)_n-S)-$ where R_0 is a linear or branched alkyl, substituted or unsubstituted aryl or benzyl; and wherein n is 2, 3 or 4, under suitable conditions to form a cross-coupled compound having the structure:



22

23

24

25

26

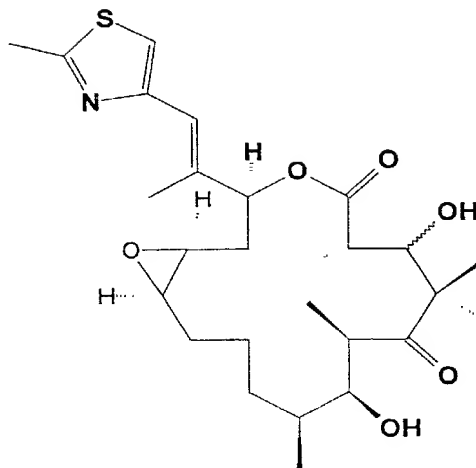
27

wherein Y is $CH(OR^*)_2$ where R^* is a linear or branched alkyl, alkoxyalkyl, substituted or unsubstituted aryloxyalkyl; and

(b) deprotecting the cross-coupled compound formed in step (a) under suitable conditions to form the open-chain compound.

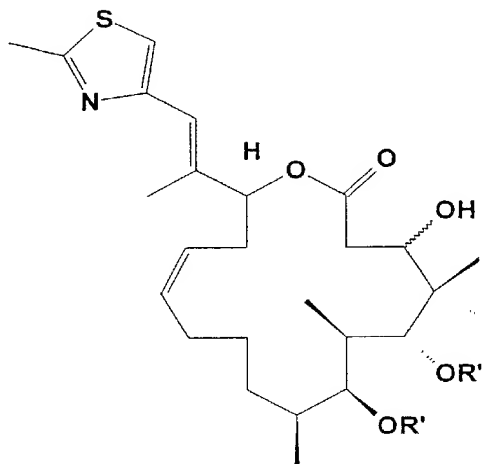
1 26. A method of preparing an epothilone having the structure:

- 99 -



which comprises:

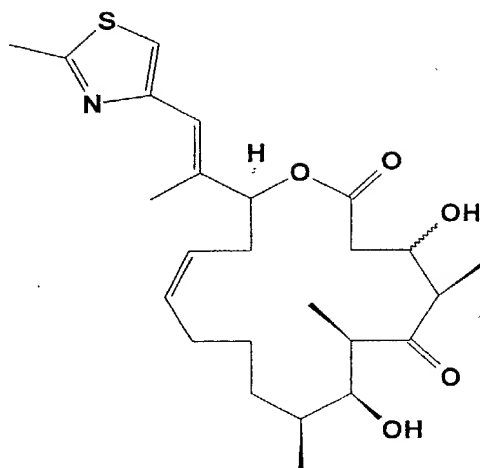
- (a) deprotecting a cyclized compound having the structure:



wherein R' and R'' are independently hydrogen, a linear or branched alkyl, substituted or unsubstituted aryl or benzyl, trialkylsilyl, dialkylarylsilyl, alkyldiarylsilyl, a linear or branched acyl, substituted or unsubstituted aroyl or benzoyl, under suitable conditions to form a deprotected cyclized compound and oxidizing the deprotected cyclized compound under suitable conditions to form a desoxyepothilone having the structure:

-100-

16



17
18
19

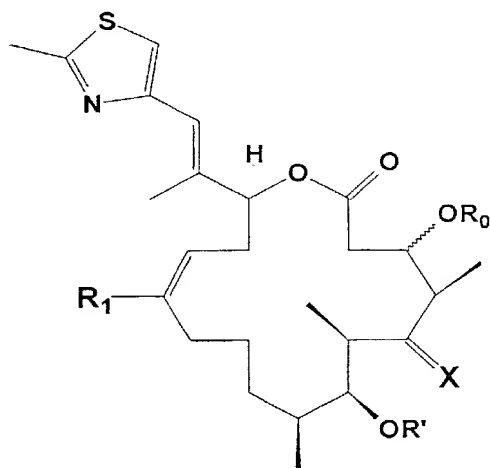
and

20
21

- (b) epoxidizing the desoxyepothilone formed in step (a) under suitable conditions to form the epothilone.

1
2

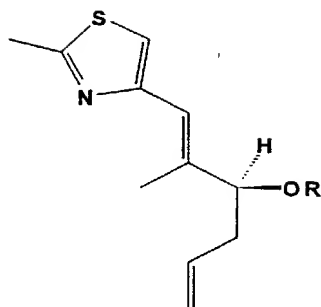
27. A method of preparing an epothilone precursor having the structure:



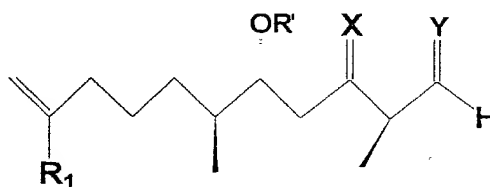
3
4
5
6
7
8
9
10

- wherein R_1 is hydrogen or methyl; wherein X is O, or a hydrogen and OR'' , each singly bonded to carbon; and wherein R_0 , R' and R'' are independently hydrogen, a linear or branched alkyl, substituted or unsubstituted aryl or benzyl, trialkylsilyl, dialkylarylsilyl, alkyl diarylsilyl, a linear or branched acyl, substituted or unsubstituted aroyl or benzoyl, which comprises
- (a) coupling a compound having the structure:

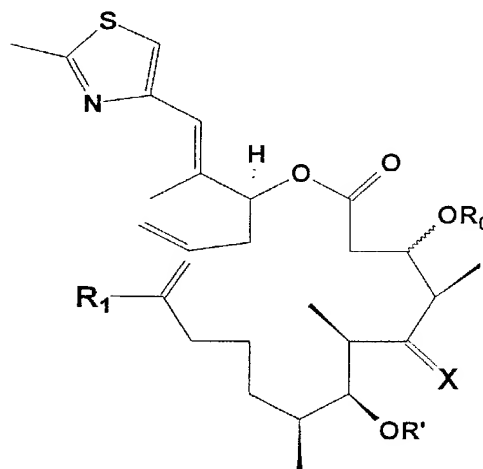
-101-



wherein R is an acetyl, with an aldehyde having the structure:



wherein Y is oxygen, under suitable conditions to form an aldol intermediate and optionally protecting the aldol intermediate under suitable conditions to form an acyclic epothilone precursor having the structure:



(b) subjecting the acyclic epothilone precursor to conditions leading to intramolecular olefin metathesis to form the epothilone precursor.

28. The method of claim 27 wherein the conditions leading to intramolecular olefin metathesis require the presence of an organometallic catalyst.

29. The method of claim 27 wherein the catalyst is a Ru or Mo complex.

30. A pharmaceutical composition for treating cancer comprising a compound of claim 1,

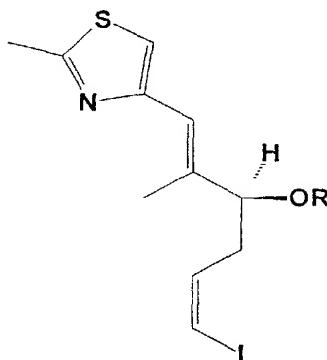
3, 5, 7, or 8 and a pharmaceutically suitable carrier.

31. A method of treating cancer in a subject suffering therefrom comprising administering to the subject a therapeutically effective amount of a compound of claim 1, 3, 5, 7 or 8 and a pharmaceutically suitable carrier.

32. The method of claim 31 wherein the cancer is a solid tumor.

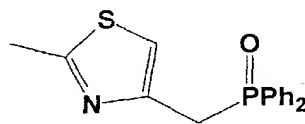
33. The method of claim 31 wherein the cancer is breast cancer.

34. A method of preparing a Z-iodoalkene ester having the structure:

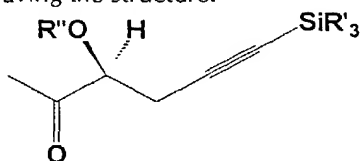


wherein R is hydrogen, a linear or branched alkyl, alkoxyalkyl, substituted or unsubstituted aryloxyalkyl, linear or branched acyl, substituted or unsubstituted aroyl or benzoyl, which comprises

(a) coupling a compound having the structure:



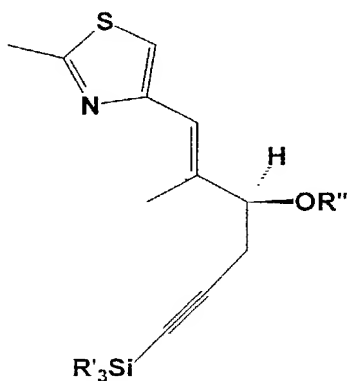
with a methyl ketone having the structure:



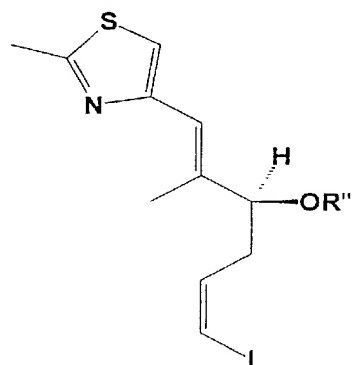
wherein R' and R'' are independently a linear or branched alkyl,

-103-

alkoxyalkyl, substituted or unsubstituted aryl or benzyl, under suitable conditions to form a compound having the structure:



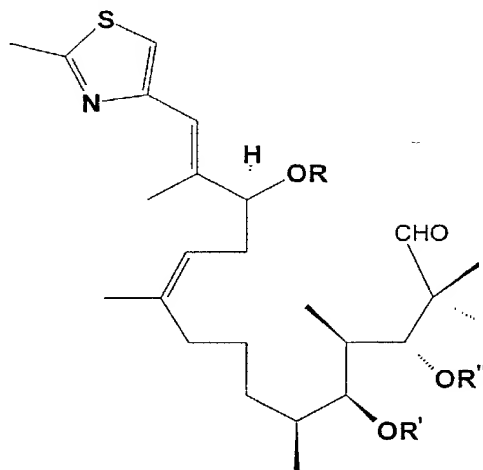
(b) treating the compound formed in step (a) under suitable conditions to form a Z-iodoalkene having the structure:



and

(c) deprotecting and acylating the Z-iodoalkene formed in step (b) under suitable conditions to form the Z-iodoalkene ester.

35. A method of preparing an open-chain aldehyde having the structure:

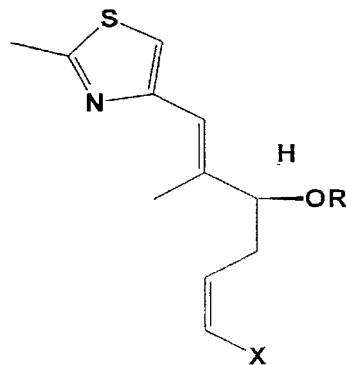


wherein R is a linear or branched alkyl, alkoxyalkyl, substituted or unsubstituted

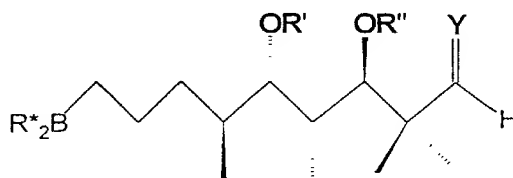
-104-

aryloxyalkyl, trialkylsilyl, aryldialkylsilyl, diarylalkylsilyl, triarylsilyl, linear or branched acyl, substituted or unsubstituted aroyl or benzoyl; and wherein R' and R'' are independently hydrogen, a linear or branched alkyl, substituted or unsubstituted aryl or benzyl, trialkylsilyl, dialkylarylsilyl, alkyldiarylsilyl, a linear or branched acyl, substituted or unsubstituted aroyl or benzoyl, which comprises:

(a) cross-coupling a haloolefin having the structure:



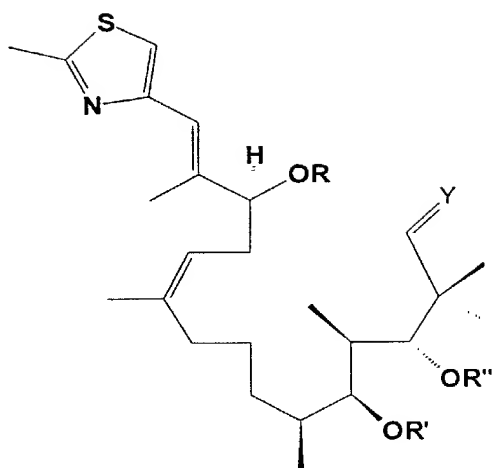
wherein X is a halogen, with a terminal hydroborane having the structure:



wherein R*B is a linear, branched or cyclic alkyl or substituted or unsubstituted aryl or benzyl boranyl moiety; wherein Y is (OR₀)₂, (SR₀)₂, - (O-(CH₂)_n-O)-, -(O-(CH₂)_n-S)- or -(S-(CH₂)_n-S)- where R₀ is a linear or branched alkyl, substituted or unsubstituted aryl or benzyl; and wherein n is 2, 3 or 4, under suitable conditions to form a cross-coupled compound having the structure:

-105-

23



24

25

26

27

and

- (b) deprotecting the cross-coupled compound formed in step (a) under suitable conditions to form the open-chain aldehyde.

1

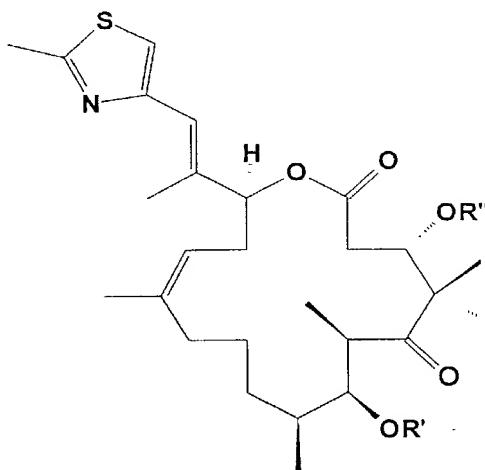
36. The method of claim 35 wherein R is acetyl; R' is TBS; R'' is TPS; R₂B is derived from 9-BBN; and Y is (OMe)₂.

2

1

37. A method of preparing a protected epothilone having the structure:

2



3

4

5

6

7

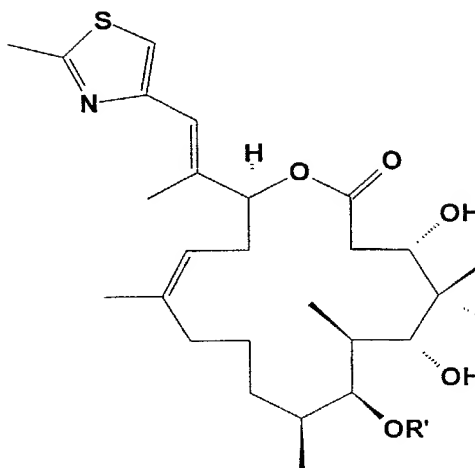
8

wherein R' and R'' are independently hydrogen, a linear or branched alkyl, substituted or unsubstituted aryl or benzyl, trialkylsilyl, dialkyl-arylsilyl, alkyldiarylsilyl, a linear or branched acyl, substituted or unsubstituted aroyl or benzoyl, which comprises:

- (a) monoprotecting a cyclic diol having the structure:

-106-

9



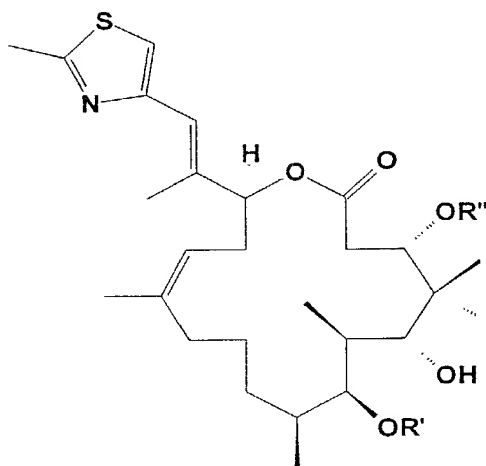
10

11

12

13

under suitable conditions to form a cyclic alcohol having the structure:



14

15

and

16

(b) oxidizing the cyclic alcohol formed in step (a) under suitable conditions to form the protected epothilone.

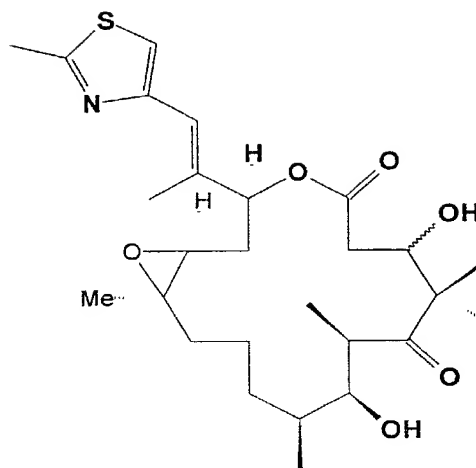
17

38. The method of claim 37 wherein R' and R'' are TBS.

39. A method of preparing an epothilone having the structure:

-107-

2



3

4

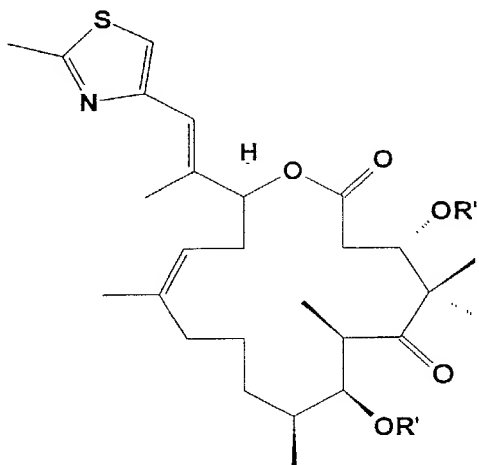
which comprises:

5

(a) deprotecting a protected cyclic ketone having the structure:

6

7



8

9

wherein R' and R'' are independently hydrogen, a linear or branched alkyl, substituted or unsubstituted aryl or benzyl, trialkylsilyl, dialkylarylsilyl, alkylarylsilyl, a linear or branched acyl, substituted or unsubstituted aroyl or benzoyl, under suitable conditions to form a desoxyepothilone having the structure:

10

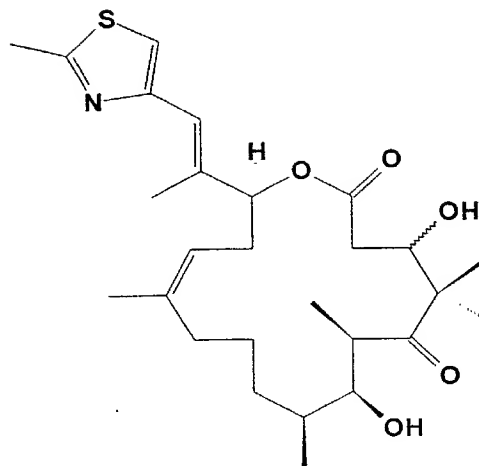
11

12

13

-108-

14



15

16

and

17

- (b) epoxidizing the desoxyepothilone formed in step (a) under suitable conditions to form the epothilone.

18

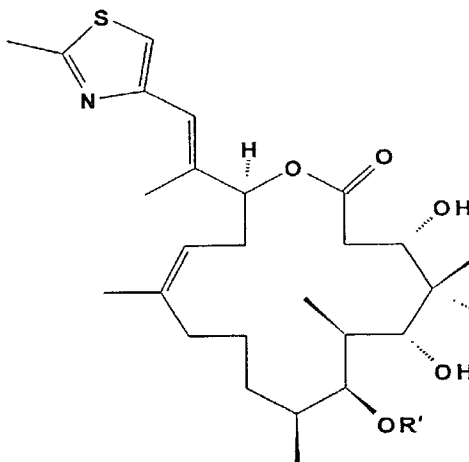
1

40. The method of claim 39 wherein R' and R'' are TBS.

1

41. A method of preparing a cyclic diol having the structure:

2



3

4

wherein R' is a hydrogen, a linear or branched alkyl, substituted or unsubstituted aryl or benzyl, trialkylsilyl, dialkylarylsilyl, alkyl diarylsilyl, a linear or branched acyl, substituted or unsubstituted aroyl or benzoyl, which comprises:

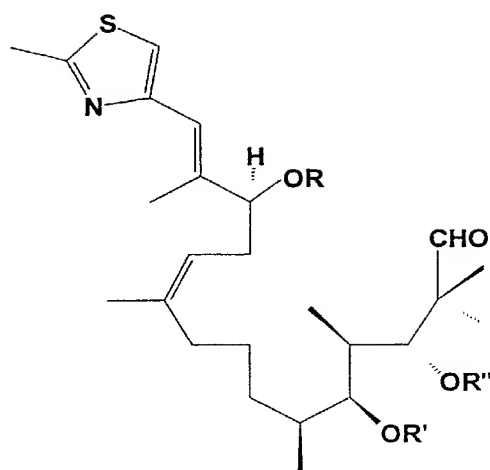
6

7

- (a) cyclizing an open-chain aldehyde having the structure:

-109-

8



9

10

11

12

13

14

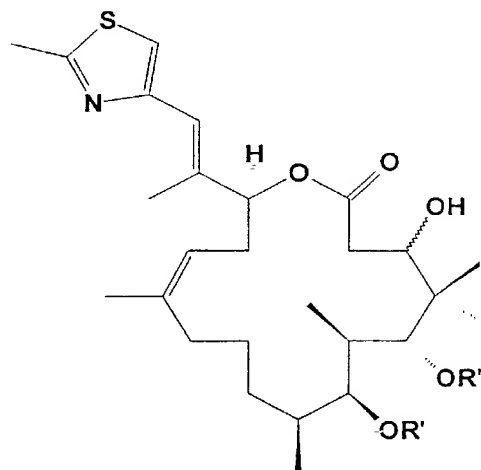
15

16

17

18

wherein R is a linear or branched alkyl, alkoxyalkyl, substituted or unsubstituted aryloxyalkyl, trialkylsilyl, aryldialkylsilyl, diarylalkylsilyl, triarylsilyl, linear or branched acyl, substituted or unsubstituted aroyl or benzoyl; and wherein R' is a hydrogen, a linear or branched alkyl, substituted or unsubstituted aryl or benzyl, trialkylsilyl, dialkylarylsilyl, alkylarylsilyl, a linear or branched acyl, substituted or unsubstituted aroyl or benzoyl under suitable conditions to form an enantiomeric mixture of a protected cyclic alcohol having the structure:



19

20

21

22

23

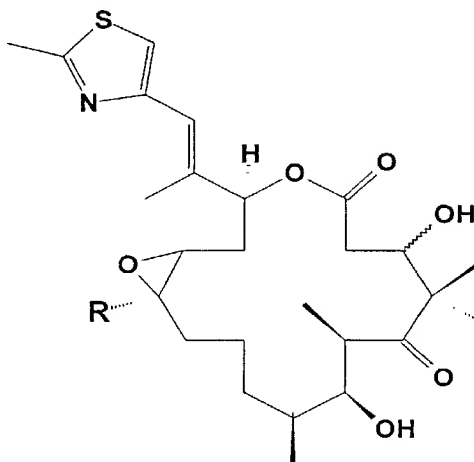
24

25

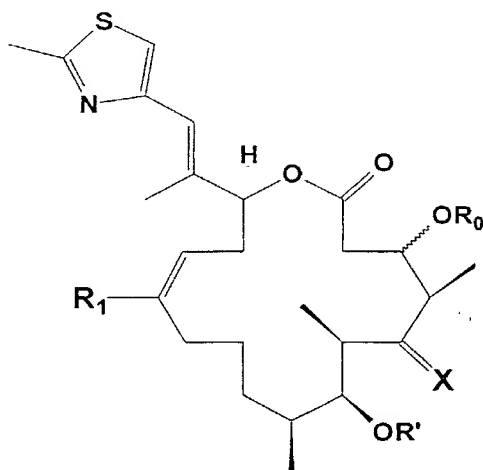
26

- said mixture comprising an α - and a β -alcohol component;
- (b) optionally isolating and oxidizing the α -alcohol formed in step (a) under suitable conditions to form a ketone and thereafter reducing the ketone under suitable conditions to form an enantiomeric mixture of the protected cyclic alcohol comprising substantially the β -alcohol; and
- (c) treating the protected cyclic alcohol formed in step (a) or (b) with a deprotecting agent under suitable conditions to form the cyclic diol.

- 1 43. A purified compound having the structure:



- 1 44. A purified compound having the structure:



- 1 45. A composition comprising an amount of the compound of claim 1, 2, 3, 4, 5, 6, 7, 8,
2 43 or 44 effective to inhibit the growth of multidrug resistant cells and a

- 111 -

- 3 pharmaceutically acceptable carrier.
- 1 46. The composition of claim 45, further comprising an amount of a cytotoxic agent.
- 1 47. The composition of claim 46, wherein the cytotoxic agent is an anticancer agent.
- 1 48. The composition of claim 47, wherein the anticancer agent is adriamycin.
- 1 49. The composition of claim 47, wherein the anticancer agent is vinblastin.
- 1 50. The composition of claim 47, wherein the anticancer agent is paclitaxel.
- 1 51. The composition of claim 45, wherein the effective amount of the compound is
2 between about 0.01 mg/kg to about 25 mg/kg of body weight.
- 1 52. A method of inhibiting the growth of multidrug resistant cells comprising contacting
2 the multidrug resistant cells with an amount of the compound of claim 1, 2, 3, 4, 5,
3 6, 7, 8, 43 or 44 effective to inhibit the growth of multidrug resistant cells in
4 combination with a pharmaceutically acceptable carrier.
- 1 53. The method of claim 52, further comprising administering an amount of a cytotoxic
2 agent.
- 1 54. The method of claim 53, wherein the cytotoxic agent is an anticancer agent.
- 1 55. The method of claim 54, wherein the anticancer agent is adriamycin.
- 1 56. The method of claim 55, wherein the anticancer agent is vinblastin.
- 1 57. The method of claim 55, wherein the anticancer agent is paclitaxel.
- 1 58. The method of claim 55, wherein the effective amount of the compound is between
2 about 0.01 mg/kg to about 25 mg/kg of body weight.